Operational Precipitation from GPCP: PERSIANN

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Project Description

- PERSIANN (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks) algorithm is used to produce more than 30-year of daily precipitation data (1979-current time). Global monthly GPCP precipitation data is used to adjust daily PERSIANN rainfall. The adjusted daily PERSIANN is consistent to the GPCP rainfall at monthly scale.

- Inputs: GridSat-B1 CDR Data (IRWIN)
                      GPCP monthly v2.2

- Output: GPCP adjusted PERSIANN precipitation
                      Resolution: Daily, $0.25^o \times 0.25^o$ Lat-Lon scale
                      Coverage: Near global coverage 60^oS to 60^oN

- Output format: NetCDF-4 to allow for metadata and
                      the global grid (480 rows x 1440 cols).

Project Description

| CDR(s) (Validated Outputs)	Period of Record	Spatial Resolution; Projection information	Time Step	Data format	Inputs	Uncertainty Estimates (in percent or error)	Collateral Products (unofficial and/or unvalidated)
Near Global PERSIANN Precipitation	1979-current time	0.25 deg square geographic projection Global coverage 60ºN to 60ºS	Daily	Netcdf-4 Global grid	Longwave Infrared data from **GridSat–B1 IRWIN Data** CDR product (ISCCP-B1U) & **GPCP monthly precipitation v2.2**	To be added	Global/ regional/ local drought indices & flood frequency maps.

Production Approach

- Infrared data (GridSat-B1) at 7km global every 3 hours is converted to 0.25 deg geographic projection and input to PERSIANN. Output is 0.25 deg precipitation in mm/hr and accumulated to daily.

- Daily PERSIANN data is accumulated to monthly and 2.5 deg to compare to GPCP for bias adjustment. These monthly bias adjustments are then used to adjust each daily 0.25-degree PERSIANN pixel.

- Adjusted daily PERSIANN data grids will then be converted to NetCDF-4 format with the appropriate metadata to be added to the CDR

- Production requires that the IR data be run through the PERSIANN model for a complete month for GPCP adjustment.

- Challenges: Data volume and flow management. Large volumes of data are required for input and generated on output. Input data must be checked for problems and errors. Neither GridSat-B1 nor GPCP are produced on a regular basis and some errors have been found in GridSat-B1.

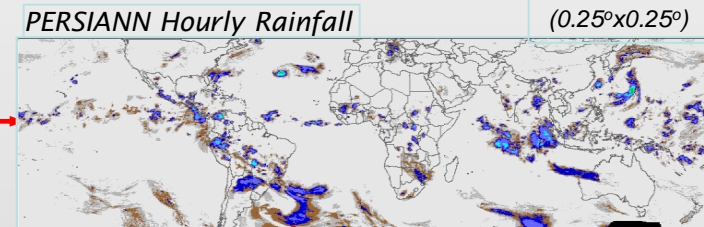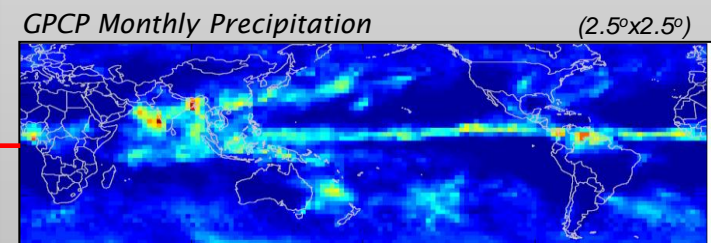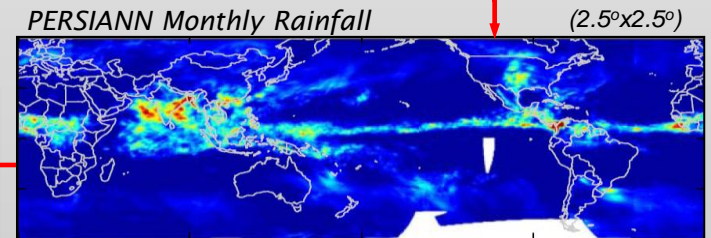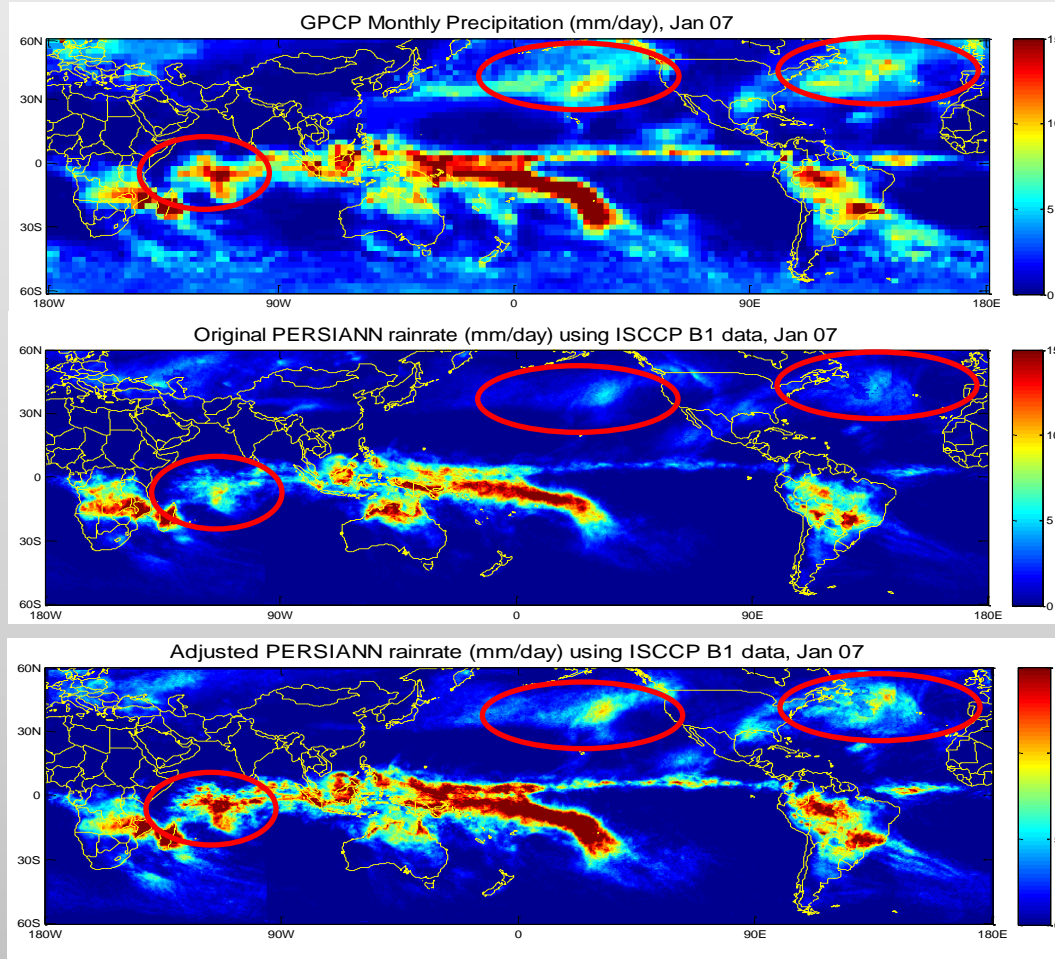# Bias Adjustment of PERSIANN Estimates
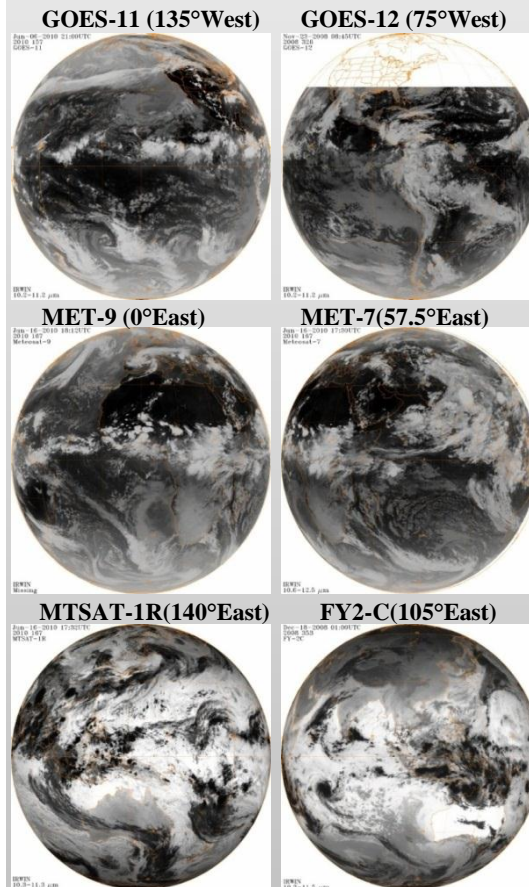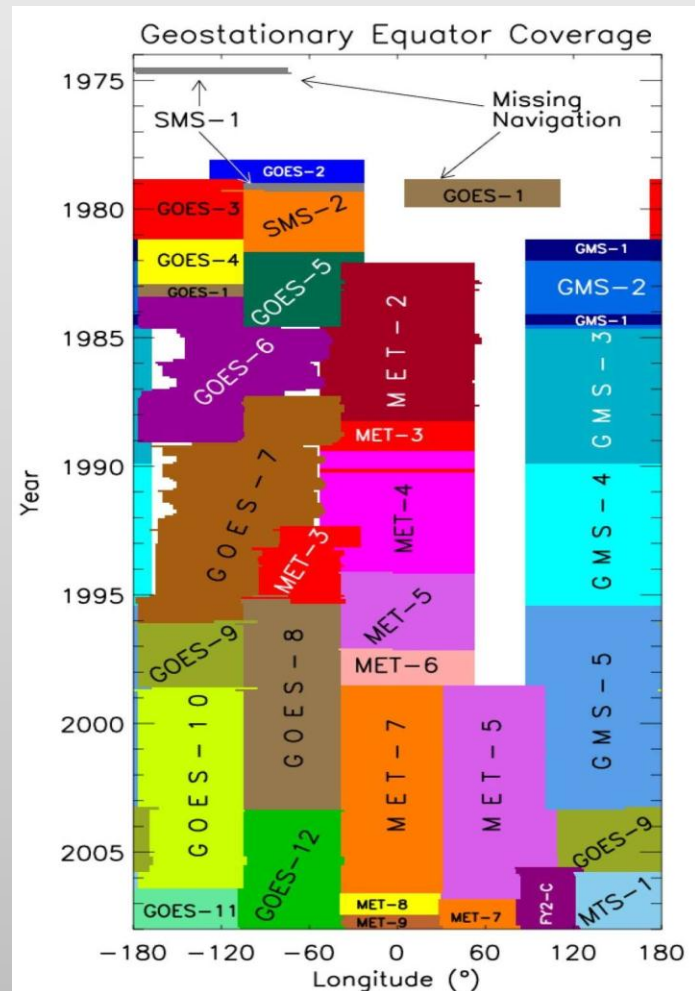
Bias Adjustment of PERSIANN Estimates
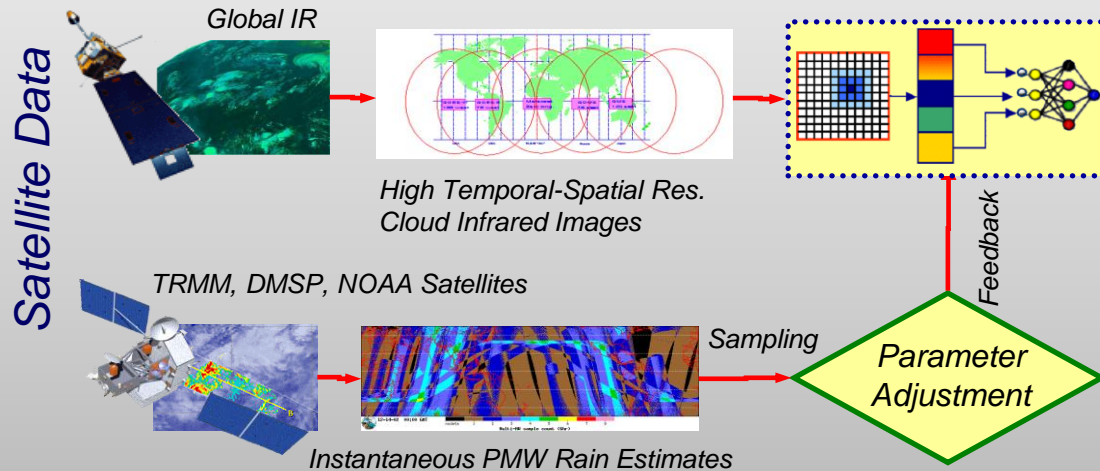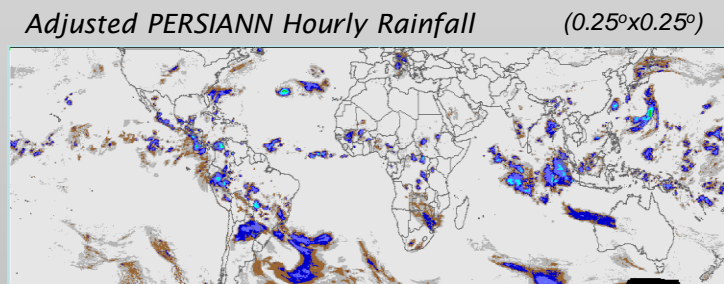
- *Comparison of GPCP monthly rainfall with PERSIANN rainfall before and after bias adjustment*
- *Bias estimates of PERSIANN rainfall at various spatial and temporal scales are adjusted using GPCP data.*
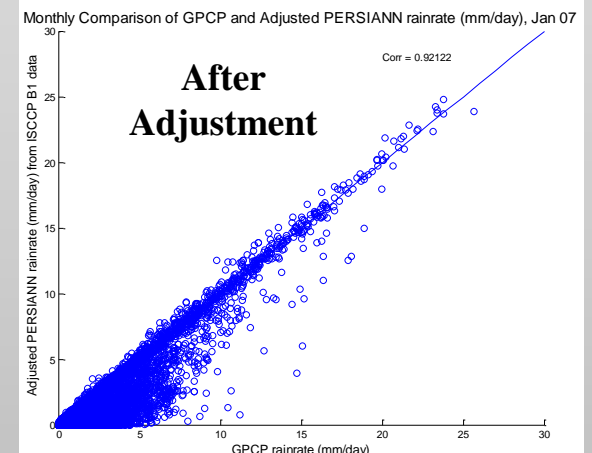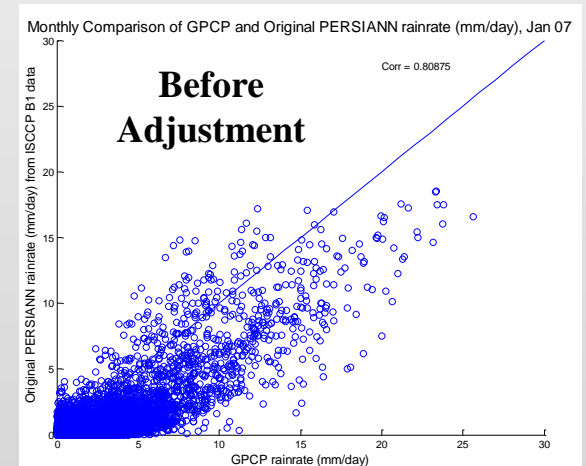
Top: GPCP Monthly, 2.5°, Middle: Original PERSIANN Monthly 0.25° , Bottom: Adjusted PERSIANN Monthly 0.25°

Input Data: GridSat-B1 CDR Data (IRWIN)

• **International Satellite Cloud Climatology Project (ISCCP)**

  1979 to present

  10-km and 3-hour intervals

Geostationary Equator Coverage

GOES-11 (135°West)   **GOES-12 (75°West)**

MET-9 (0°East)   **MET-7(57.5°East)**

**MTSAT-1R(140°East)**   **FY2-C(105°East)**

1. U.S. Geostationary Operational Environmental Satellite (**GOES**)

2. European Meteorological satellite (**Meteosat**) series

3. Japanese Geostationary Meteorological Satellite (**GMS**)

4. The Chinese Fen-yung 2C (**FY2**) series.

Source: NOAA NCDC

Input Data: GPCP Monthly Precipitation Data

- *Global Precipitation Climatology Project (GPCP)*

- **GPCP Version 2.2 Combined Precipitation Data Set**

- Global Precipitation Climatology Project monthly precipitation dataset from 1979-present combines observations and satellite precipitation data into 2.5°x2.5° global grids.
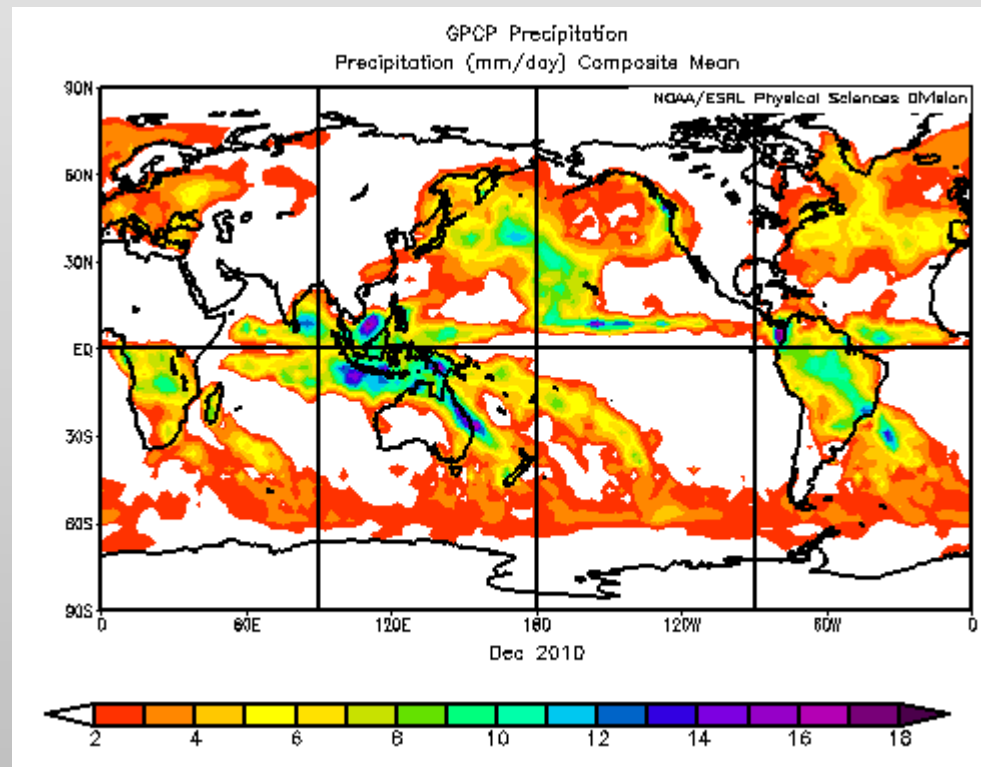
PERSIANN Estimates
(Before & After GPCP Precipitation Adjustment)

- PERSIANN before and after GPCP monthly rainfall adjustment
- Spatial resolution: 0.25º x 0.25º Lat-Long
- Temporal resolution: daily

Daily Rainfall

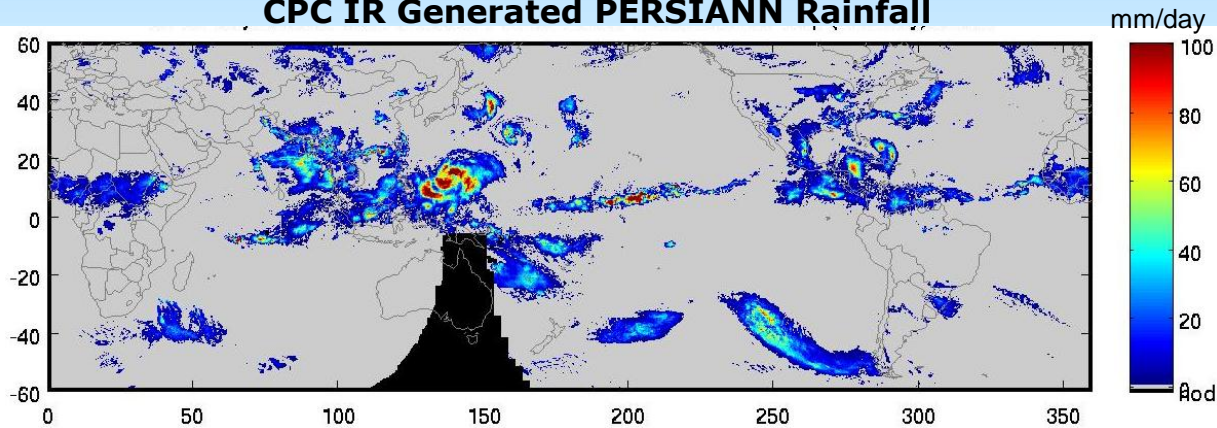Before GPCP Adjustment

After GPCP Adjustment
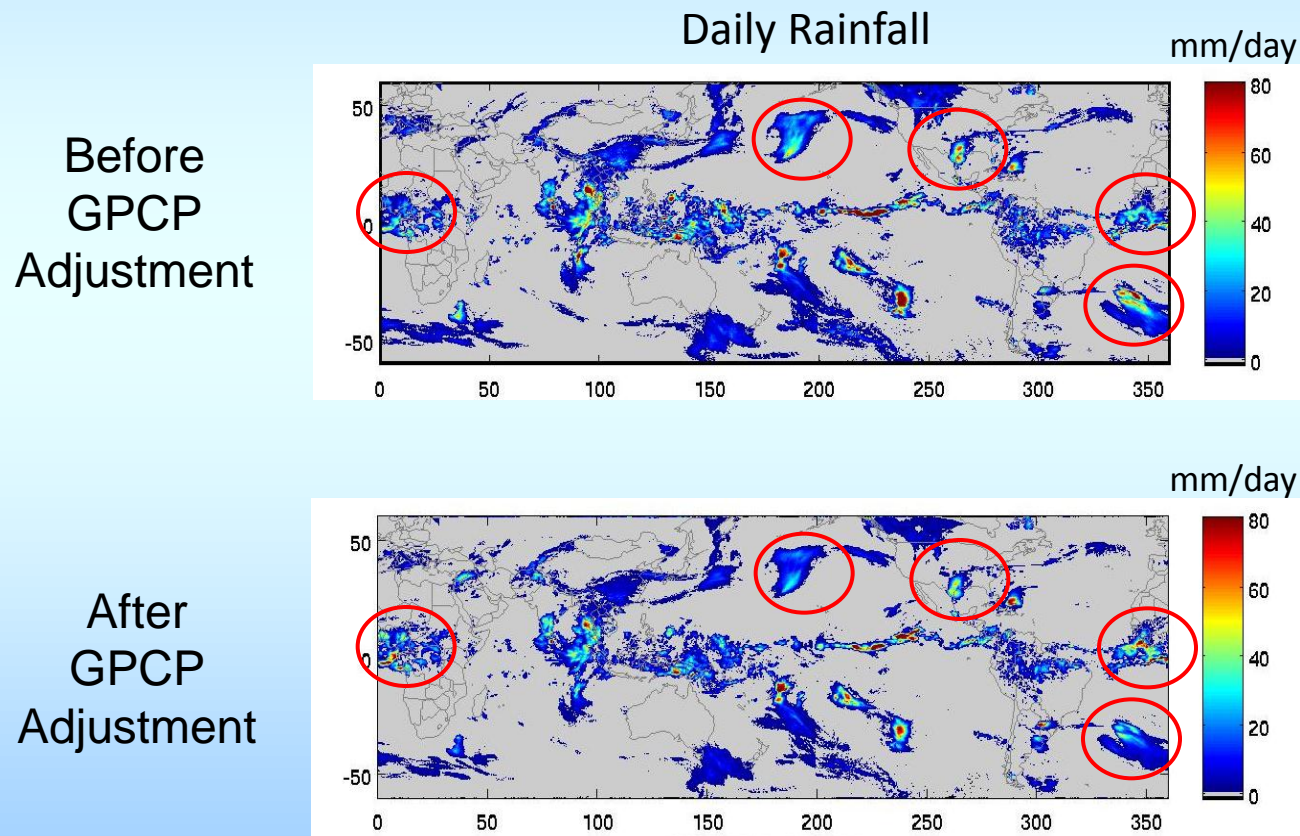
Quality Assurance Approach

- Test using CPC-IR grid data and GridSat-B1 CDR Data (IRWIN) to generate PERSIANN estimates and evaluate PERSIANN estimates (before and after GPCP monthly precipitation adjustment)

- Compare PERSIANN with GPCP 1DD daily estimation for the period of 1997—2009

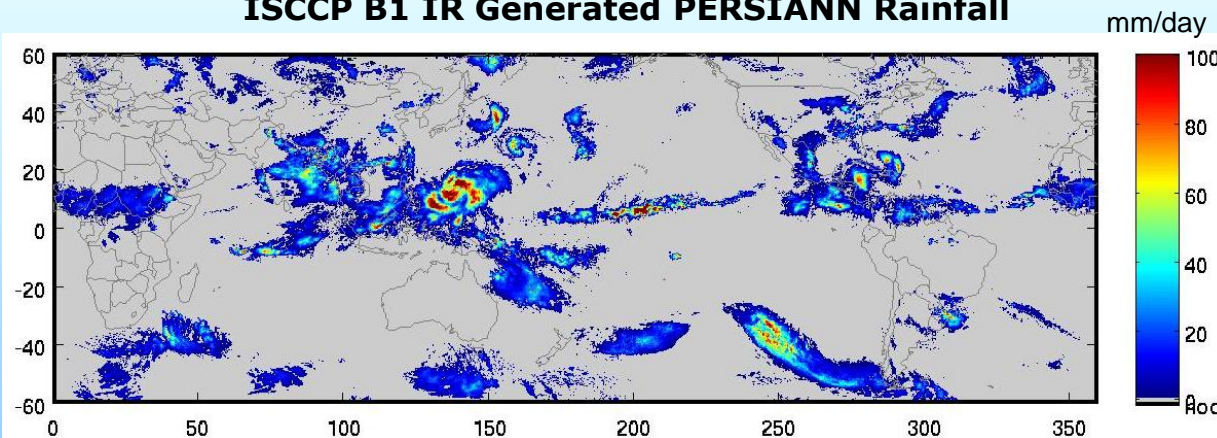- Compare PERSIANN with stage IV radar/gauge estimates over CONUS.

Generate PERSIANN Precipitation from CPC Grid IR and GridSat–B1 CDR Data

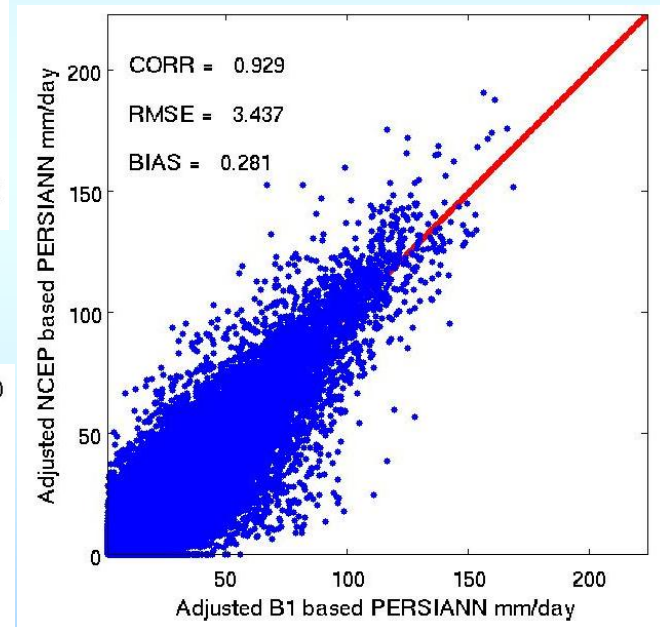## *GPCP adjusted PERSIANN Daily Rainfall Estimation: DOY 202, 2005*

CPC IR Generated PERSIANN Rainfall
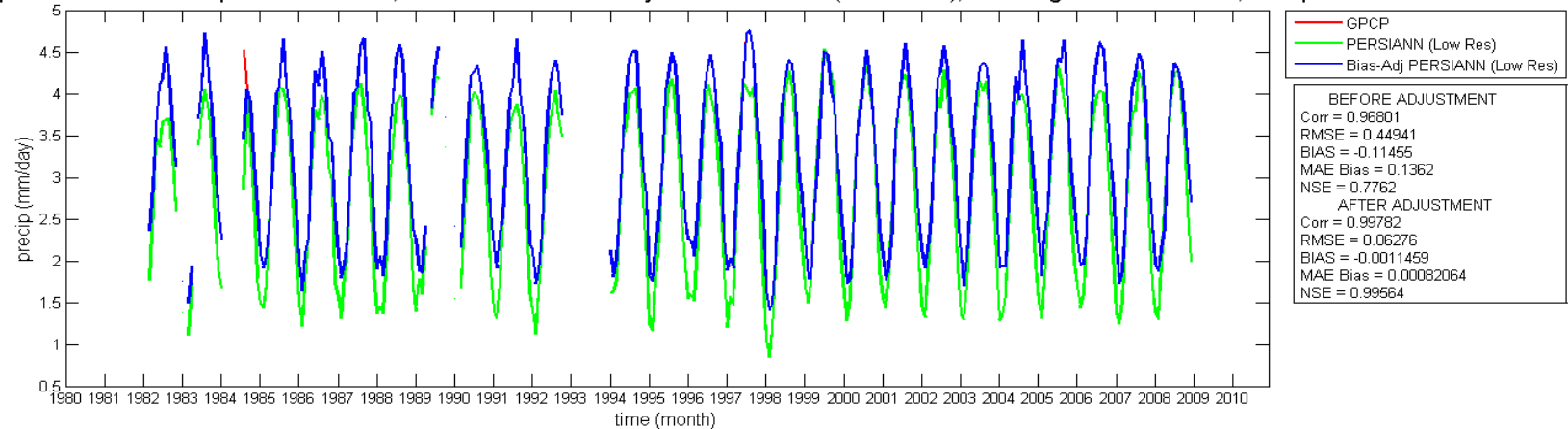

ISCCP B1 IR Generated PERSIANN Rainfall
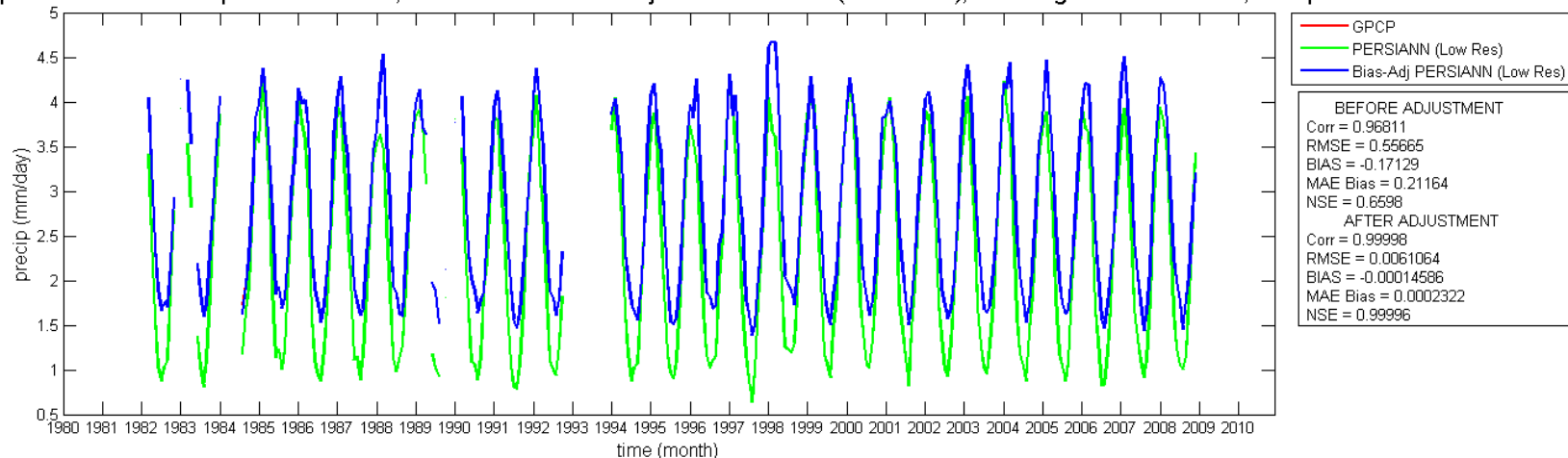

After GPCP adjustment

GPCP and PERSIANN Precipitation (0–30º)

- **Mean Areal Precipitation (MAP) for Northern and Southern hemisphere (0-30º).**
- **The GPCP adjusted PERSIANN matches GPCP monthly rainfall**

Northern Tropical Mean Areal Precipitation for GPCP, PERSIANN and Bias-Adjusted PERSIANN (1980-2010), MaxWeight = No Threshold, Precip Thresh = 0.05

GPCP
PERSIANN (Low Res)
Bias-Adj PERSIANN (Low Res)

BEFORE ADJUSTMENT
Corr = 0.96801
RMSE = 0.44941
BIAS = -0.11455
MAE Bias = 0.1362
NSE = 0.7762
AFTER ADJUSTMENT
Corr = 0.99782
RMSE = 0.06276
BIAS = -0.0011459
MAE Bias = 0.00082064
NSE = 0.99564

Southern Tropical Mean Areal Precipitation for GPCP, PERSIANN and Bias-Adjusted PERSIANN (1980-2010), MaxWeight = No Threshold, Precip Thresh = 0.05
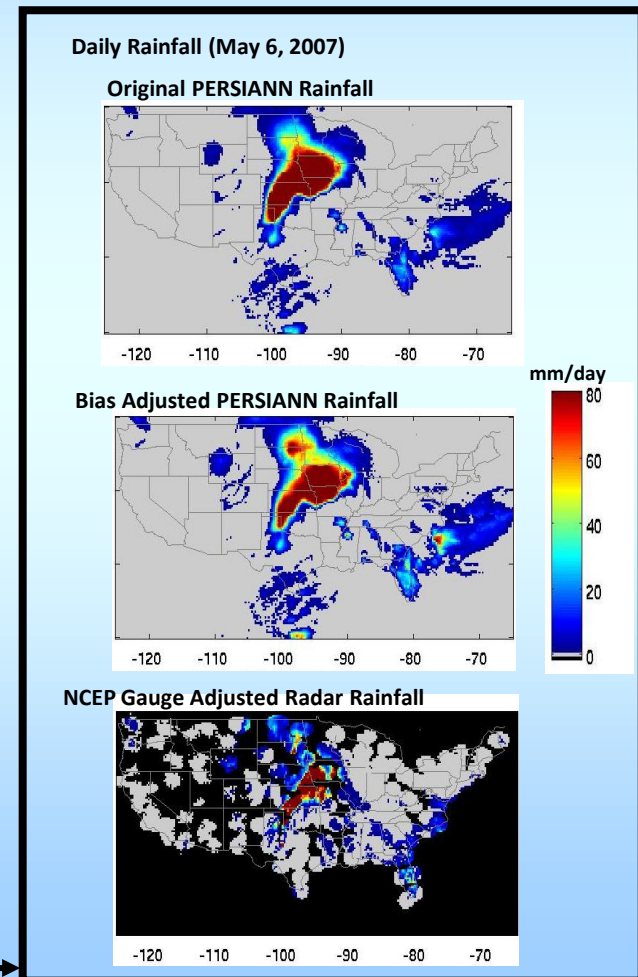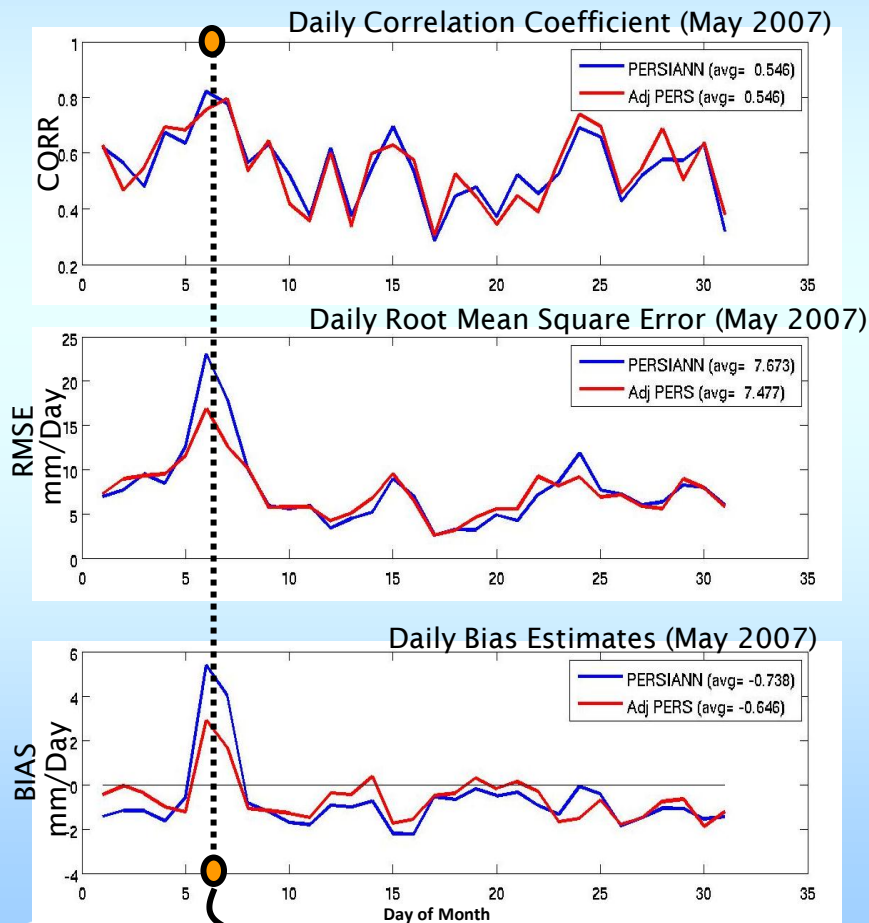
GPCP
PERSIANN (Low Res)
Bias-Adj PERSIANN (Low Res)

BEFORE ADJUSTMENT
Corr = 0.96811
RMSE = 0.55665
BIAS = -0.17129
MAE Bias = 0.21164
NSE = 0.6598
AFTER ADJUSTMENT
Corr = 0.99998
RMSE = 0.0061064
BIAS = -0.00014586
MAE Bias = 0.0002322
NSE = 0.99996

GPCP 1–DD and PERSIANN Precipitation (0–30°N)

- **Comparison of the PERSIANN and Bias-Adjusted PERSIANN with Daily GPCP product (1-DD)**
- **Data evaluation: Data Period: 1997—2009. Data Coverage: 0—30°N**
- **Bias-Adjusted PERSIANN estimates are consistent with the GPCP Daily (1-DD) estimates.**
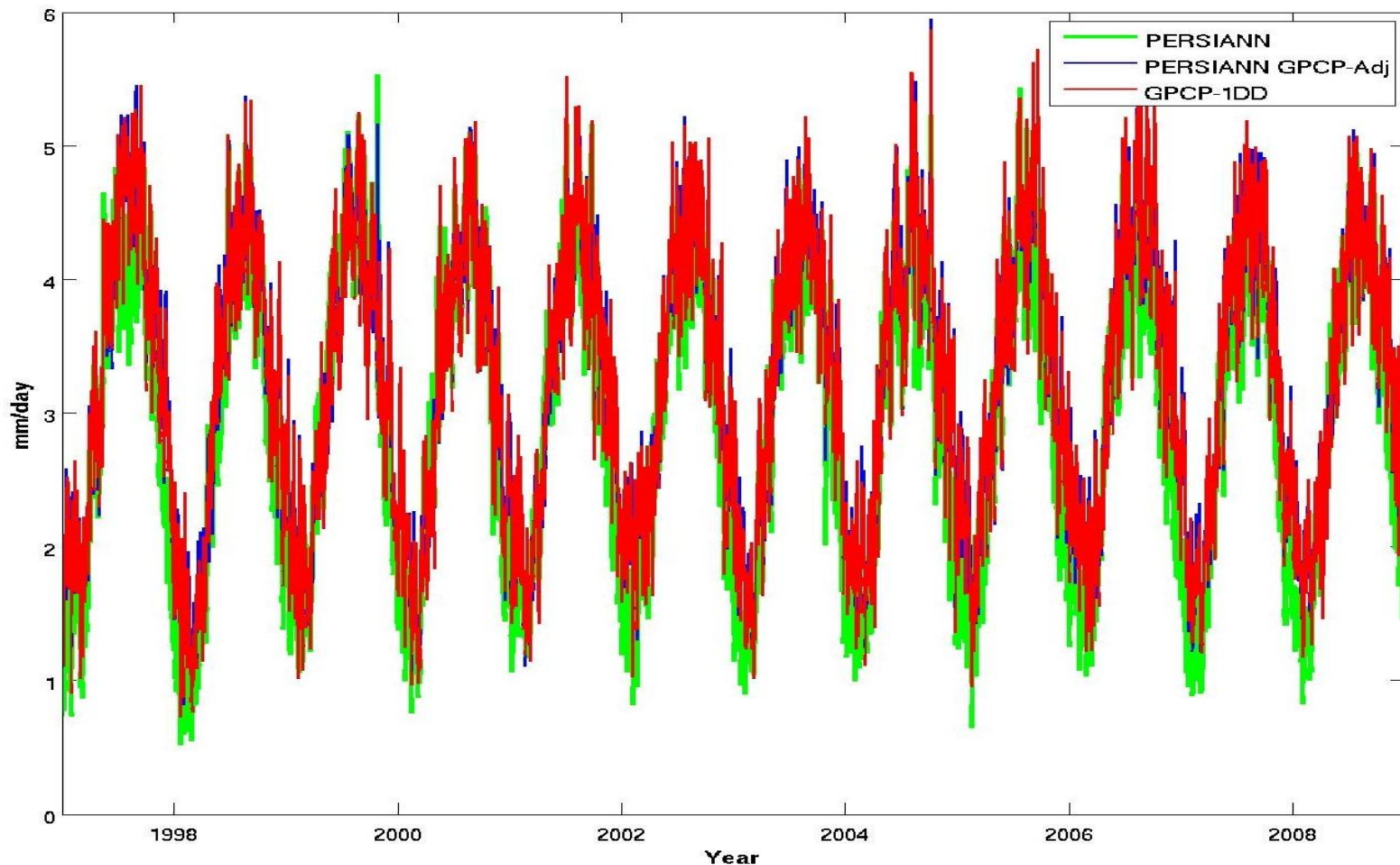
PERSIANN and Stage IV Estimates

- **NCEP gauge adjusted radar rainfall is used to evaluate PERSIANN rainfall**
- **Day-by-day evaluation statistics (CORR, RMSE, and BIAS) are listed**
- **With adjustment from GPCP monthly rainfall, evaluation statistics (RMSE and BIAS) are improved from non-adjusted PERSIANN rainfall**

Daily Correlation Coefficient (May 2007)

PERSIANN (avg= 0.546)
Adj PERS (avg= 0.546)

Daily Root Mean Square Error (May 2007)

PERSIANN (avg= 7.673)
Adj PERS (avg= 7.477)

Daily Bias Estimates (May 2007)

PERSIANN (avg= -0.738)
Adj PERS (avg= -0.646)

Day of Month

Daily Rainfall (May 6, 2007)

Original PERSIANN Rainfall

Bias Adjusted PERSIANN Rainfall

NCEP Gauge Adjusted Radar Rainfall

mm/day

Applications: Water Focus

- **Applications:**
  - Water resources systems planning and management
  - Extreme events analysis (intensity, frequencies, and duration of floods & droughts)
- **Users:**
  - Dept. of Water Resources (DWR), State and National Water Agencies
  - USGS, NWS, WMO UNESCO-IHP
  - International partners to validation the products: Taiwan, India, Israel, Italy, Thailand, Namibia…

PERSIANN CDR for Hydro–climatological Application

Algorithm
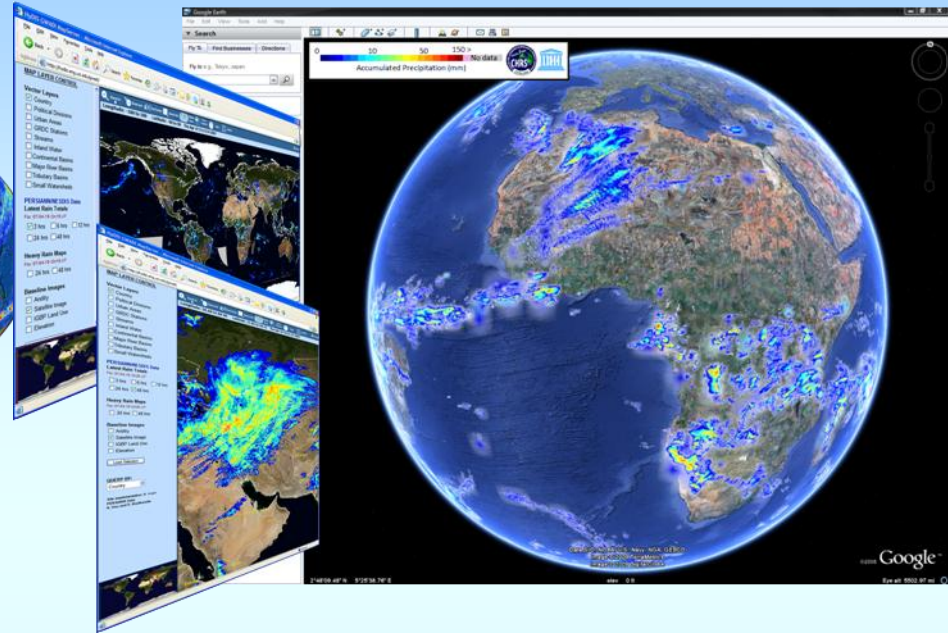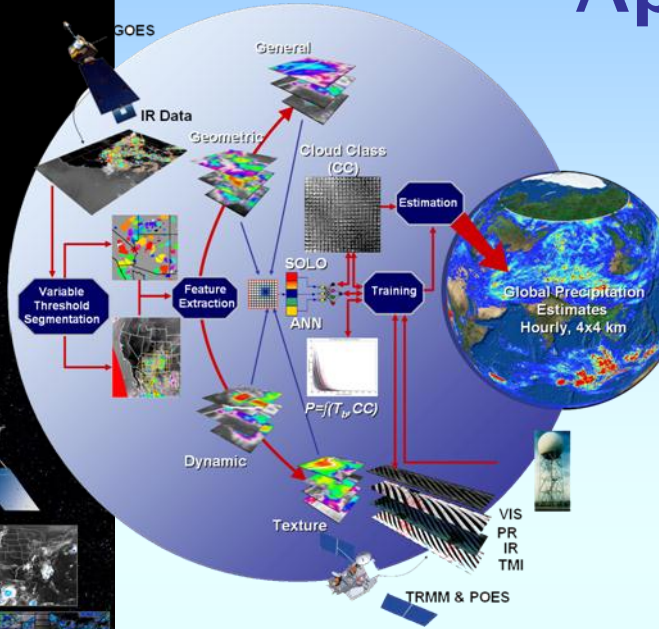
Web Services

Applications

Drought Management   **Flood Forecasting**   **Water Resources**
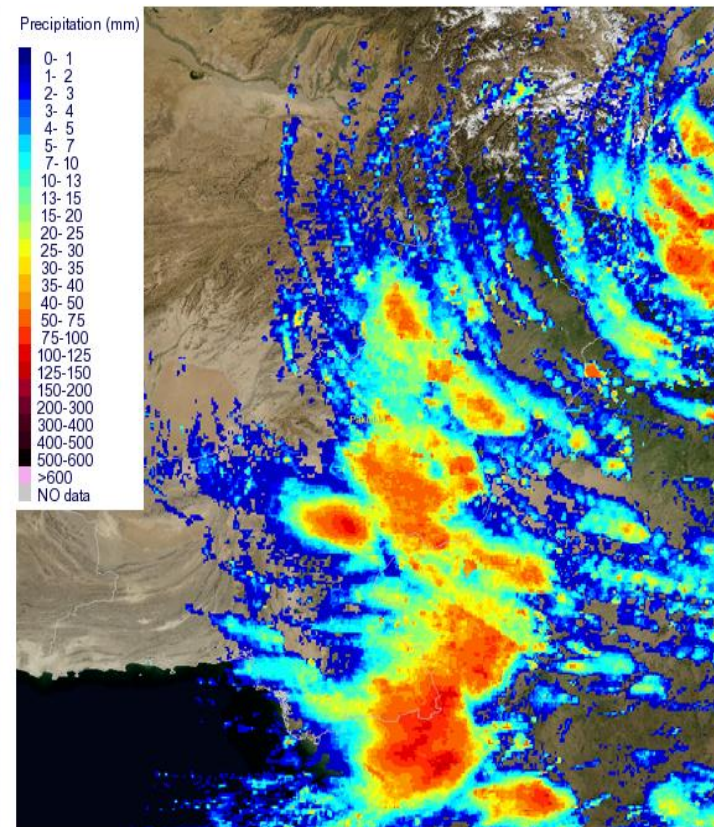
Extreme Event Analysis: Floods (intensity, frequency, duration…)
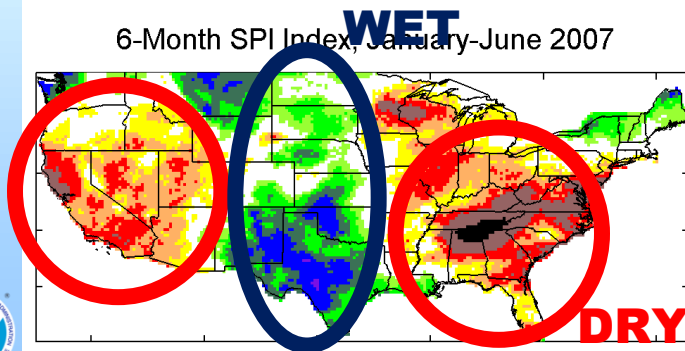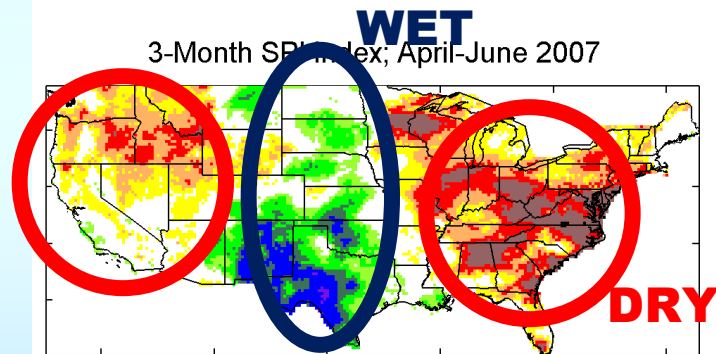
Pakistan Flood

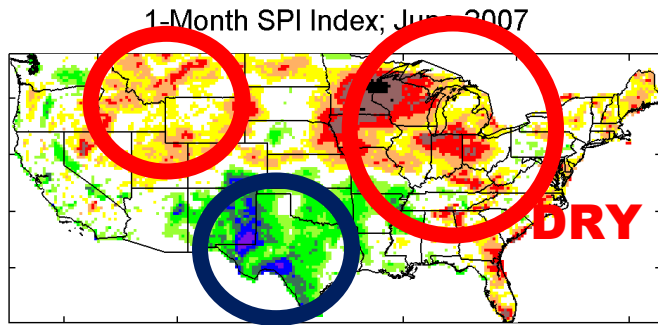08-09-2010 22:00 UTC 24-hr Accumulation
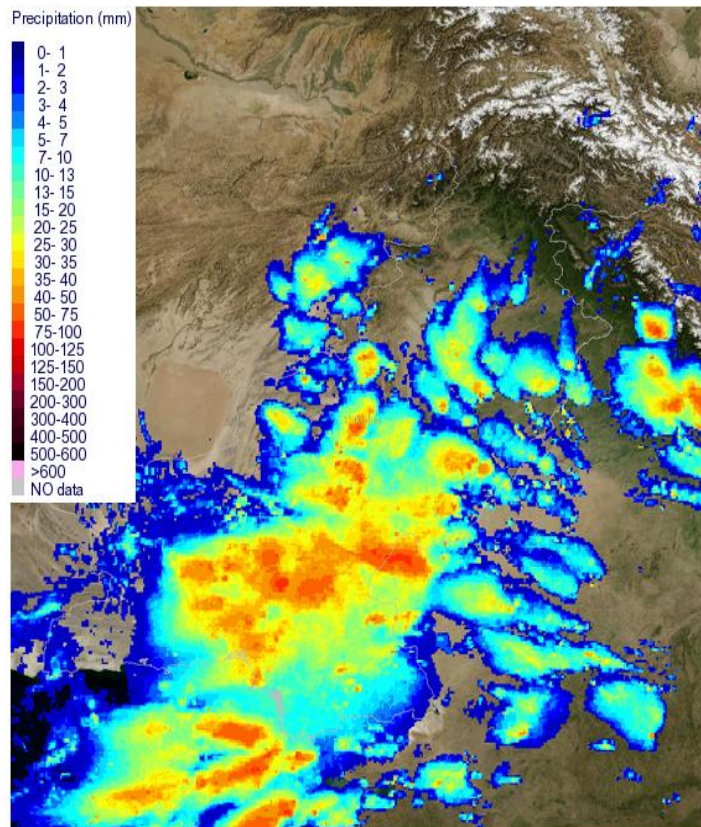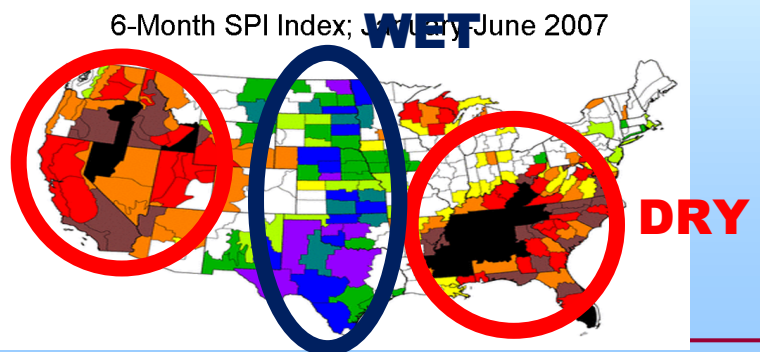
08-04-2010 17:17 UTC 24-hr Accumulation

Extreme Event Analysis: Drought Monitoring (intensity, frequency, duration…)
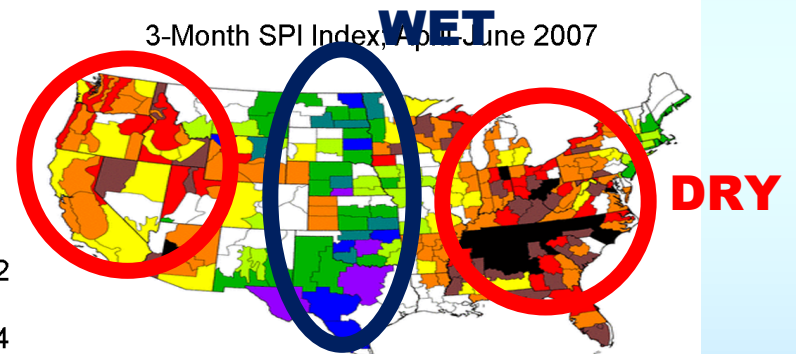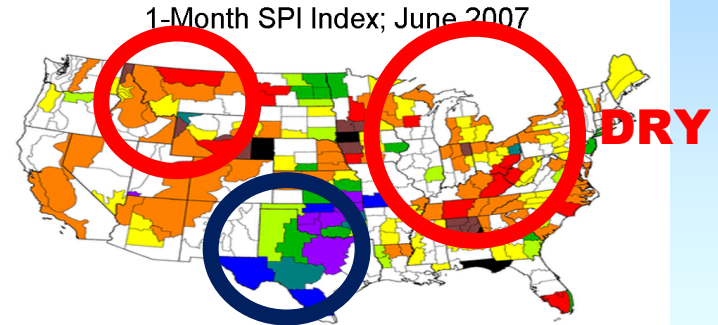
Schedule & Issues

- State project current status
  - Downloaded and processed Grid-B1 CDR Data (IRWIN)
  - Run and test PERSAINN and GPCP adjusted PERSIANN codes
  - Download GPCP monthly rainfall 1970~2010
  - Generated multi-year PERSIANN data: 1980~2010

- Plans for next phase of the project
  - Evaluate products (Local, regional, and global evaluation using gauge, radar, and other better quality data sources)
  - Examine data quality and reprocess/remove data with problems
  - Quantify the uncertainty of estimates

- Risks or concerns
  - Our product updates are dependent on input data sources (Grid-B1 and GPCP).
  - GridSat-B1 is completed through year 2009 and has some errors/problems required further attention. The data from 2010~current time is not ready.
  - GPCP v2.2 completed through year 2010. The data from 2010~current time is not ready.

Known issues on GridSat–B1

- Some data under the Meteosat coverage are not assigned correctly